WSDOT WETLAND MITIGATION SITES

SOUTHWEST REGION

2001 MONITORING REPORT

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Issued March 2002

Washington State Department of Transportation

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Introduction

History

Infrastructure improvements including highway construction projects, highway interchanges, and bridges have accompanied economic and population growth in the state of Washington. The Washington State Department of Transportation (WSDOT) routinely evaluates the potential for degradation of critical areas that result from these infrastructure improvements. WSDOT strictly complies with applicable federal, state, and local environmental regulations, including the Clean Water Act and the state "no net loss" policy for wetlands (Executive Order 89-10 1989). Generally, mitigation sites are planned when transportation improvement projects affect critical areas. The WSDOT Wetland Monitoring Program monitors these mitigation sites as a means of evaluating compliance with permit conditions and tracking overall development. Fifty sites were monitored in 2001 (Map 1).

Purpose

The purpose of this document is to report the status of Southwest Region WSDOT mitigation sites with respect to permit compliance and success standards for 2001 (Map 2). We rely on feedback from the users of this report to ensure its contents are clear, concise, and meaningful.

Process

Site monitoring typically begins the first spring after a site is planted. Sites are monitored for the time period designated by the permit or mitigation plan. The monitoring period generally ranges from three to ten years.

Monitoring activities are driven by site-specific success standards detailed in the mitigation plan or site permits. Data are collected on a variety of environmental parameters including vegetation, hydrology, and wildlife. After data analysis is complete, information on site development is communicated to region site managers to facilitate management activities on sites through an adaptive management process. Permitting agencies receive annual site reports that document site compliance with success standards and other permit conditions.

Methods

Methods used for monitoring mitigation sites change as site requirements and customer needs evolve. Quantitative data collection techniques presently in use are based on standard ecological and biostatistical methods.[1] The Monitoring Program's current methods include the following key concepts:

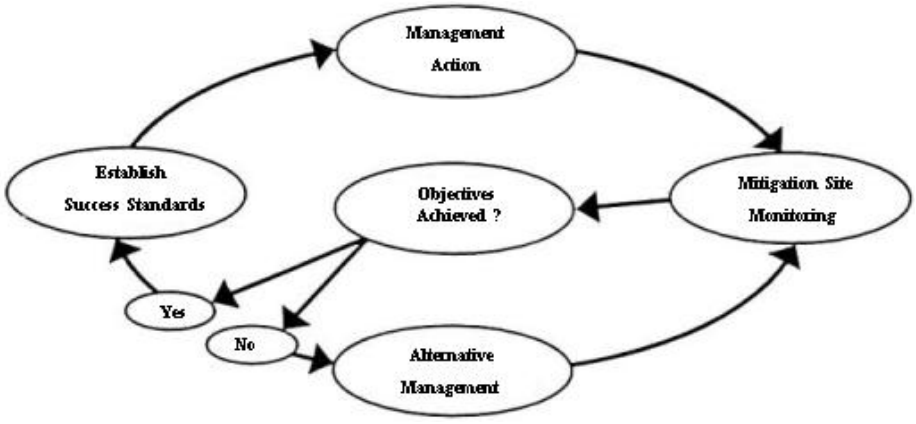
Objective-Based Monitoring

We collect data using a monitoring plan and sampling design developed specifically for each site. The monitoring plan and sampling design address success standards, contingencies, and other considerations as appropriate.

Adaptive Management

The adaptive management process is illustrated in Figure 1 (Elzinga et al. 1998). In this process: (1) success standards are developed to describe the desired condition; (2) management action is carried out to meet the success standard; (3) the response of the resource is monitored to determine if the success standard has been met; and (4) management is adapted if the standards are not achieved. Monitoring is a critical component of the adaptive management process, providing the link between success standards and management activities. Sound management decisions based on credible monitoring data can save resource management dollars when implemented in a timely fashion as part of an effective adaptive management strategy (Shabman 1995).

Figure 1. The Adaptive Management Process



[1]These methods are based on techniques described in Bonham (1989), Elzinga (1998), Krebs (1999), Zar (1999), and other sources.

Statistical Rigor

The monitoring program strives to eliminate subjectivity in data collection and increase the reliability of data analysis. Important considerations include appropriate sampling design, sampling resolution, random sampling procedures, and sample size analysis. Our goal is to provide customers with an objective evaluation of site conditions based on valid and reliable monitoring data.

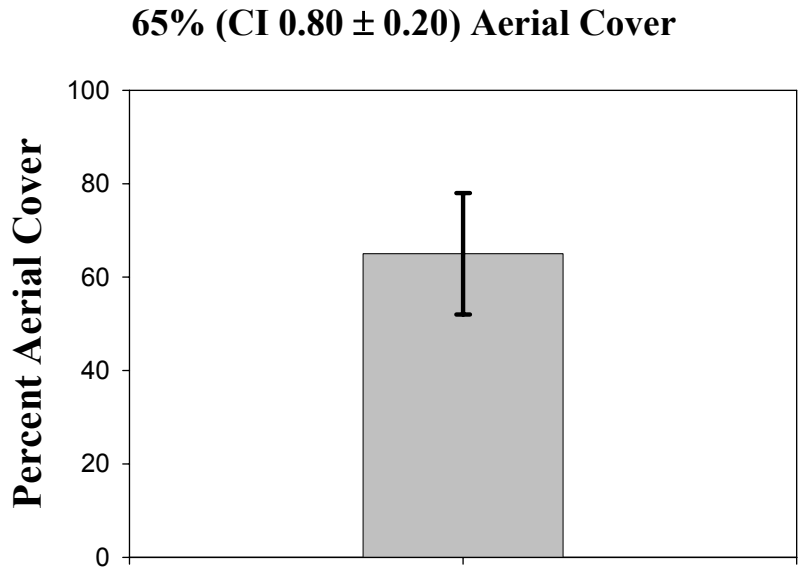
Success Standards

Site objectives and success standards are important elements of any mitigation plan. They indicate the desired state or condition of the mitigation site at a given point in time. Some mitigation plans also provide contingencies if a specific undesirable condition occurs. Contingencies typically initiate a management response when a threshold is not achieved, such as excessive cover by invasive species or insufficient cover by trees and shrubs.

Monitoring program staff thoroughly examines goals, objectives, success standards, and site permits to understand the desired site condition or characteristics to be measured. Six elements are sought in relation to each success standard to ensure measurability of the desired condition: species indicator, location, attribute, action, quantity/status, and time frame. Where one or more of the six elements is undocumented or unclear in the mitigation plan or permit, clarification is sought from region staff.

Sampling is required to address success standards unless a total accounting of the target attribute can be conducted efficiently and reliably. Sampling objectives are then developed to guide the monitoring process. Depending on the type of analysis to be done, sampling objectives may include a confidence level and confidence interval half width (Figure 2). These results are included in the individual site reports with the confidence

Figure 2. Estimated Cover Value Expressed with Confidence Interval Range



level and confidence interval noted as (CI X ± Y), where CI = confidence interval, X = confidence level, and Y = confidence interval half width. For example, an estimated aerial cover provided by woody species shown as 65% (CI 0.80 ± 0.20) means that we are eighty percent confident that the reported value is within twenty percent of the true value. In this case, we are eighty percent confident the true aerial cover value is between 78% and 52% (Figure 2).

Vegetation Monitoring

For compliance purposes, aerial cover calculations include only areas covered by vascular plants (including floating-leaved species). Areas covered by thallophytes, bryophytes, structures, or aquatic vegetation are not included in aerial cover calculations. Scientific names, common names, hydrophytic plant indicator status, and nativity used in this report were obtained from the PLANTS Database (USDA 2001). Where invasive or noxious weeds are addressed, county specific listings in the State Noxious Weed List are referenced (Washington State Noxious Weed Control Board 2001).[2]

Sampling Design

When sampling is required, a sampling design is developed for the site or ecological area of interest. Sampling designs can vary from simple to complex depending on the number and type of attributes to be measured. Specific elements such as the size and shape of the site, the presence of environmental gradients, plant distribution characteristics, and the amount of time and resources available for monitoring are all factors that influence the sampling design. Elements of the sampling design may include the location of the baseline, orientation of transects, and the number and type of sample units to be used. A basic diagram showing the sampling design is included in mitigation site reports where appropriate. These drawings are general representations of the actual sampling designs and do not include specific details.

The quantitative vegetation methods described below are generally employed within a sampling design framework consisting of a baseline with transects extending from it across a site (Figure 3). Depending on the sampling objective and site characteristics, transects may vary in number, length, and width of interspersion. Sampling transect locations can be determined by using a simple random sampling method, systematic

[2] In some cases, other nuisance species may be included in invasive cover estimates.

Figure 3. Baseline and Sampling Transects

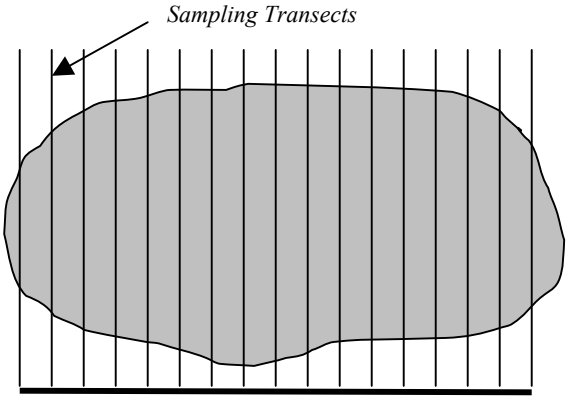
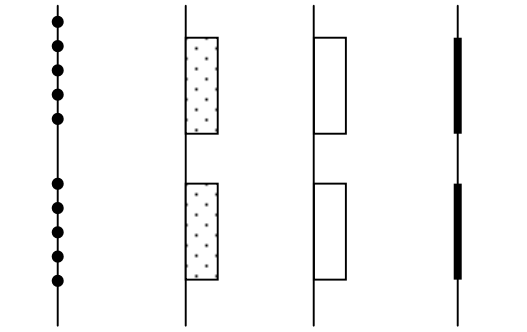


Figure 4 (a-d). Sampling Transects and Sample Units



random sampling method, stratified random sampling method, or restricted random sampling method. Sample units appropriate to one or more of the methods described below are randomly located on or adjacent to the sampling transects (Figure 4 a-d).

The Point-Line Technique

The point-line technique (Bonham 1989; Elzinga et al. 1998) is used where vegetative cover is the attribute of interest. Application of this method involves randomly locating sample units consisting of fixed sets of points along sampling transects (Figure 4a). Tools used to collect point-line data include point-intercept devices, pin flags, and densitometers. Using one of these tools, point locations are identified and all target vegetation intercepted by the point locator is recorded. If no target species are encountered on the point, bare soil, non-vascular plant, or habitat structure is recorded as appropriate. Cover is determined based on the number of hits of the target vegetation divided by the total number of points on each sample unit. The mean percent aerial cover value and standard deviation are calculated from the sample, and sample size analysis is conducted. Results are evaluated against the success standard and sampling objective.

The Point-Frame Technique

Point-frames are another tool that can be used to measure vegetative cover (Bonham 1989; Elzinga et al. 1998). A point frame is a rectangular frame that houses a number of points collectively serving as a sample unit (Figure 4b).[3] The sample unit can be lowered onto herbaceous vegetation and hits recorded where target vegetation intercepts point locations. The number of hits on target vegetation is divided by the total number of point locations on the sample unit to determine a percent aerial cover value. As with the point-line method, a mean percent aerial cover value and standard deviation are generated for the sample, and sample size analysis is performed.

[3] The WSDOT Monitoring Program typically uses a frame formed with polyvinyl chloride (PVC). Strings span the frame lengthwise and points are marked on the strings using a standard randomization method.

Survival and Density Estimates

To measure survival or density of planted trees and shrubs in an area, quadrat sample units can be randomly located along sampling transects (Bonham 1989; Elzinga et al. 1998). Quadrat width and length is based on characteristics of the vegetative community and patterns of plant distribution. Quadrats are typically located lengthwise along sampling transects (Figure 3c). Once the placement of the quadrats has been selected, plants are recorded as alive or dead. The success standard or contingency threshold can be addressed with a mean percent survival estimate of plantings, or a density per square meter of living plantings as appropriate. Sample size is analyzed to address the sampling objective.

Line Intercept

Cover data for the woody species community is collected using the line intercept method (Bonham 1989; Elzinga et al.1998).[4] Line segments, serving as sample units, are randomly located along sampling transects (Figure 4d). All woody vegetation intercepting a tape measure stretched the length of each sample unit is identified and the length of each canopy intercept recorded. The sum of the canopy intercept lengths on each sample unit is divided by the total length of each sample unit to calculate aerial cover values. Data are analyzed to address the success standard and sampling objective.

Sample Size Analysis

With each of the above methods, sample size analysis is performed to ensure that an adequate number of sample units are obtained. For data reported in this document, the following equation for estimating a single population mean or a population total within a specified level of precision was used to perform this analysis (Elzinga et al. 1998).

$$n = \frac{(z)^2(s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[5]
n = unadjusted sample size

[4] Depending on site conditions and other considerations, woody cover data is also collected using the point-line method and a densitometer.

[5] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

A sample size correction to *n* is necessary for adjusting "point-in-time" parameter estimates.[6] It is the adjusted *n* value that reveals the number of sample units required to report the estimated mean value at a specified level of confidence. In this document, site reports indicate whether a sufficient number of sample units were obtained to achieve the sampling objectives based on adjusted *n* values.

Wildlife Monitoring

Bird Monitoring

Sites that require bird monitoring receive three to four bird surveys conducted from April through June each year. The point count method (Ralph et al. 1993) is used to document species richness and relative abundance.

Species diversity indices (H) are calculated for each data set using the Shannon-Wiener function (Krebs 1999). A mean annual species diversity index is calculated for each site.

$$H' = -\sum_{i=1}^{s} (p_i)(\log p_i)$$

H' = index of species diversity
s = number of species
p_i = proportion of sample belonging to *i*th species

The following *t* test is used to test the null hypothesis that diversity indices from different years are equal (Zar 1999).

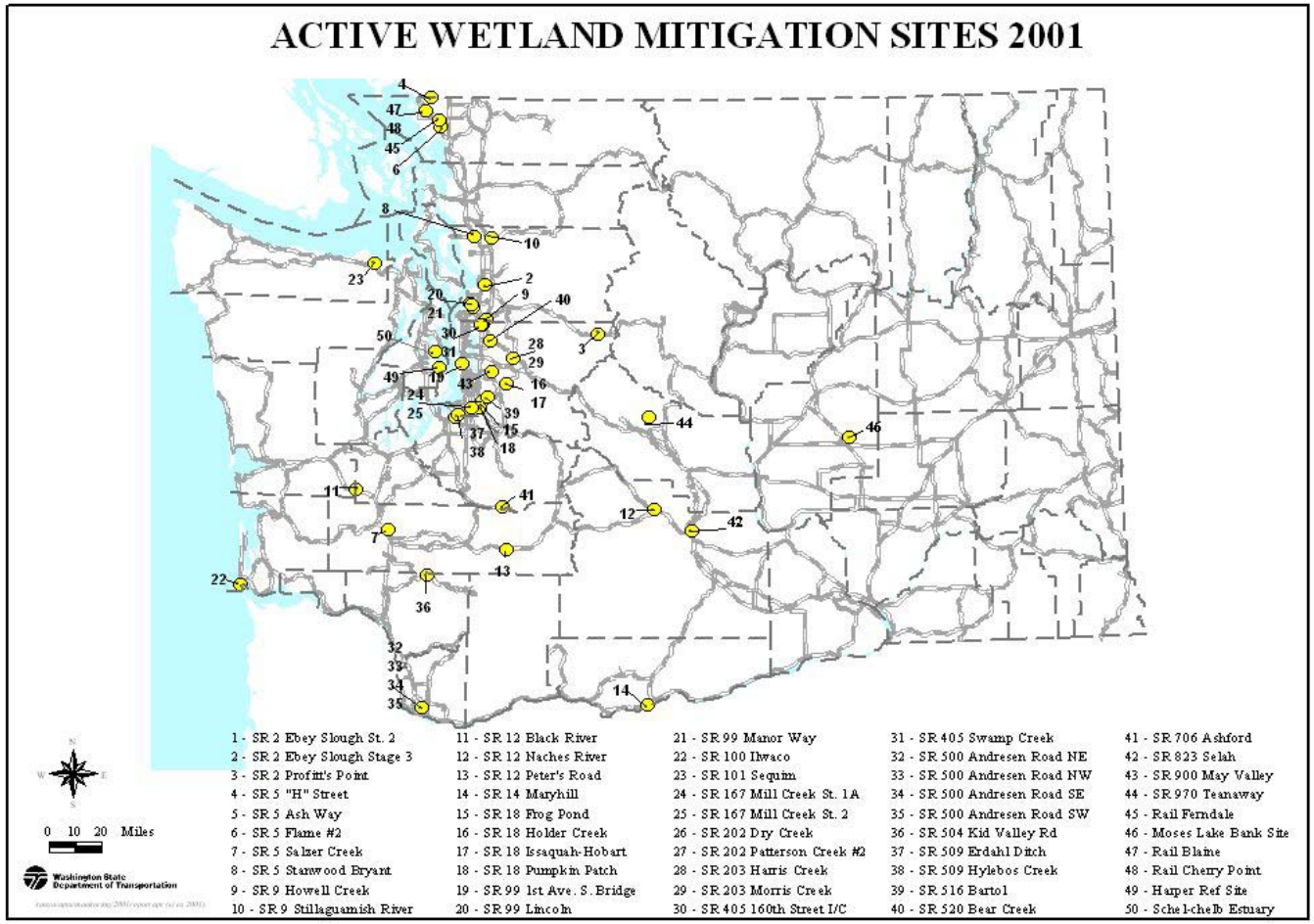
$$t = \frac{H'_1 - H'_2}{S_{H'_1 - H'_2}}$$

H' = index of species diversity
$S_{H'_1 - H'_2}$ = standard error of the difference between species diversity indices H'_1 and H'_2

Incidental wildlife observations are recorded during all site visits.

[6] Adjusted *n* values found in this report were obtained using the algorithm for a one-sample tolerance probability of 0.90 (Kupper and Hafner 1989; Elzinga et al 1998).

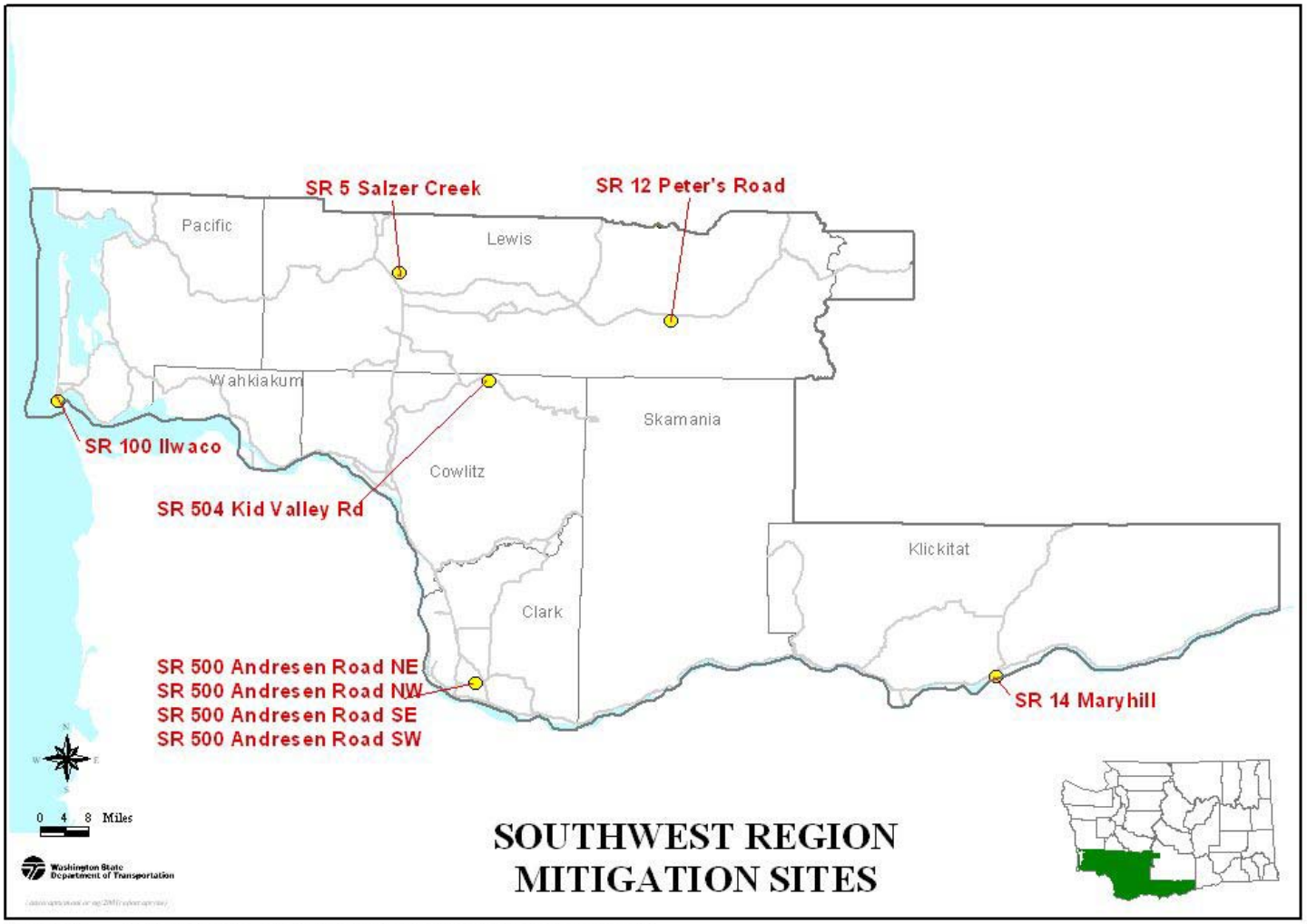
Map 1: WSDOT Mitigation Sites Monitored in 2001



Map 1: WSDOT Mitigation Sites Monitored in 2001

2001 Monitoring Report

Map 2: Southwest Region Mitigation Sites Monitored in 2001



Map 2: Southwest Region Mitigation Sites Monitored in 2001

Southwest Region Office *2001 Monitoring Report*

SR 12 Peters Road, Lewis County

Summary

Site Name	Success Standard	2001 Results	Mgmt Activities
SR 12 Peters Road	Less than 15% cover by invasive species each year through 2008	13% (CI 0.80 ± 0.20)	Weed control, replanting

The following report summarizes project activities completed by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program at the SR 12 Peters Road restoration site in August 2001. Activities included vegetation surveys to address the third year success standard.

Site Information

Site Name	SR 12 Peters Road
Project Name	SR 12 Peters Road Slide Repair
Location	Lewis County, Washington
Township/Range/Section	T.12N/R.7E/S.7
Monitoring Period	1999-2008
Year of Monitoring	3 of 10
Area of Project Impact	1.1 ha (2.6 ac)
Type of Mitigation	Restoration of non-wetland riparian forest
Area of Mitigation	2.1 ha (5.3 ac)

Success Standards and Sampling Objectives

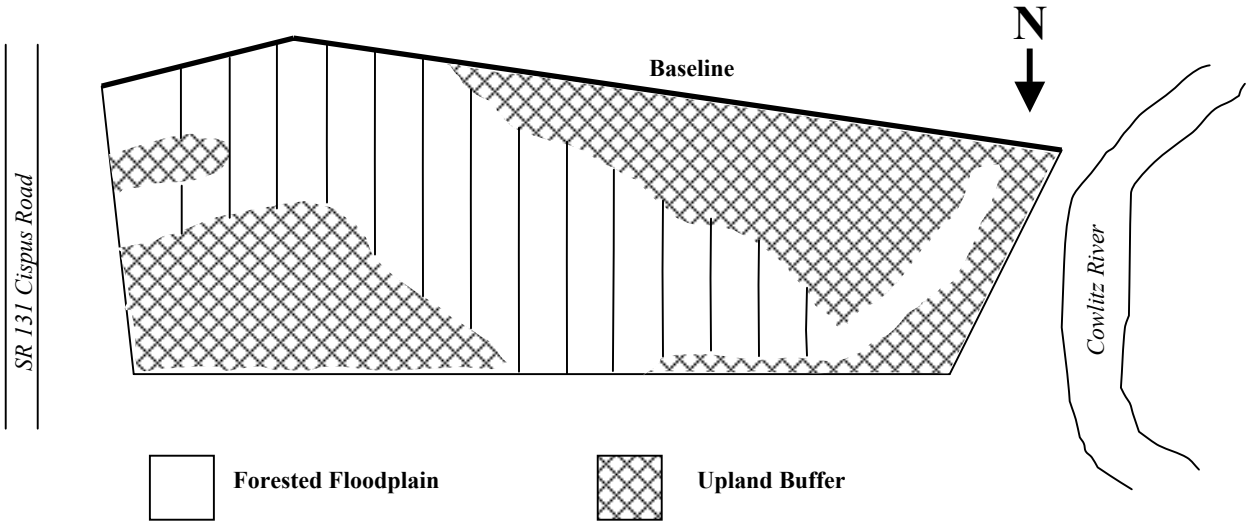
The third year success standard listed below was excerpted from the *SR 12 Peters Road Vicinity Slide Repair Wetland Mitigation Plan* (Null et al. 1998). A companion sampling objective follows. A complete text of the success standards for this site is presented in Appendix B.

> **Success Standard**
>
> In any monitoring year except year ten, the combined aerial cover of noxious or invasive non-native species throughout the site will not exceed 15%. In year ten, this combined aerial cover will not exceed 10%.
>
> Sampling Objective
>
> To be 80% confident the mean aerial cover estimate of invasive species at the SR 12 Peters Road mitigation site is within 20% of the true cover value.

Methods

To conduct sampling of the invasive plant community, a 300-meter baseline was placed along the south fence (Figure 7). A systematic random sampling method was used to place 30 transects along the baseline. Transects were extended 10° N and two 50-meter point-line sample units (100 points each) were randomly placed along each transect.

Figure 7. SR 12 Peters Road Mitigation Site Sampling Design Sketch (2001)



Sample size analysis confirmed that sufficient sampling had been completed based on sampling objectives and the desired level of statistical confidence. The following equation was used to perform this analysis (Elzinga et al. 1998).

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[7]
n = unadjusted sample size

Results and Discussion

The mean aerial cover estimate for invasive species on the entire site was 13% (CI 0.80 ± 0.20). This value is below the 15% threshold specified in the success standard. *Cirsium arvense* (Canada thistle) is the dominant invasive species on the site, with *Cirsium vulgare* (bull thistle), *Phalaris arundinacea* (reed canarygrass), *Xanthium strumarium* (rough cockle-bur), *Rubus armeniacus* (Himalayan blackberry), and *Rubus laciniatus* (cutleaf blackberry) also present.

Management Activities

Since the cover of woody species last year was only 2% (CI 0.90 ± 0.20), the adaptive management response has been to replant in spring 2001. Intensive weed control measures and supplemental planting are planned for 2002 to increase the percent cover of woody species and to bring invasive cover below the acceptable threshold.

[7] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

SR 14 Maryhill State Park, Klickitat County

The following report summarizes monitoring activities completed at the SR 14 Maryhill State Park mitigation site in May 2001 by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program. Activities included a qualitative vegetation survey.

Site Information

Site Name	Maryhill	
Project Names	SR 14 Maryhill State Park	
Location	Maryhill State Park, Klickitat Co., WA	
Township/Range/Section	T.2N/R.16E/S.5 Government Lot 3	
Monitoring Period	1999 to 2001	
Year of Monitoring	3 of 3	
Type of Mitigation	Enhancement	Enlargement
Area of Mitigation	1.4 ha (3.5 ac)	0.3 ha (0.8 ac)

Monitoring and Sampling Objectives

The *Maryhill State Park Wetland Enhancement Agreement* (Smith and Pinnix 1996) requires three years of monitoring, but does not contain goals, objectives or success standards. The above agreement directs WSDOT to develop and implement remedial activities if the Wetland Enhancement Area fails to develop successfully. Appendix A contains excerpts from the Enhancement Agreement.

Management Activities

Although this project was built to specifications, changes occurred on the Columbia River markedly altering hydrological conditions in the mitigation area after site construction. Only a small band of vegetated wetland developed under the unanticipated conditions as shown in Figure 5. Alternative management was implemented which involved modifying topography, amending soil, and replanting the entire site. Weed control and any necessary supplemental planting in the upland areas will be scheduled for 2002.

Figure 5. Maryhill Mitigation Site (2000)

Results and Discussion

A considerably larger vegetated wetland area has resulted from 2001 management activities. WSDOT Monitoring staff visited the site on May 15, 2001. Hydrophytic plants such as *Typha latifolia* (broadleaf cattail), *Populus balsamifera* (black cottonwood), and *Salix* sp. (willows) are successfully becoming established in the much expanded emergent and scrub-shrub areas shown in Figure 6. Planting survival was visually estimated at nearly 100%.

Figure 6. Maryhill Mitigation Site (2001)

Site hydrology appears sufficient to support the continued development of wetland plant communities in the perimeter of the ponds. Water depth was about 1 meter in both ponds. The south pond in particular was well vegetated with aquatic plant species.

Upland buffer plantings were surviving well at the time of monitoring with a qualitative survival estimate approaching 100%. Plantings were showing some signs of stress in the southwest corner, and were somewhat sparse on the east side of the site. The generally undesirable plant, *Rubus armeniacus* (Himalayan blackberry), was present in the northwest corner of the wetland at low cover levels.

Summary

Although this site has not achieved the level of development originally intended within the first three years, through adaptive management effective adjustments have been made. Re-grading and replanting efforts appear successful and should add substantively toward the development of higher quality emergent and scrub-shrub wetland areas. WSDOT plans to monitor this site another year to track development of these recent management activities.

SR 100 Ilwaco, Pacific County

The following report summarizes project activities completed by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program at the SR 100 Ilwaco mitigation site in 2001. Monitoring activities included a qualitative assessment of the site with respect to Year 5 Success Standards (2001), photography, and a plant list.

Site Information

Site Name	Ilwaco		
Project Names	SR 100 (Fort Canby Road)		
Permit Number	00-C4296-01 and DE 96WQ-S313		
Permitting Agency	WDFW and WSDOE		
Location	2 miles southwest of Ilwaco, Pacific Co.		
Township/Range/Section	T.9N/R.11W/S.4, SW/4		
Monitoring Period	1997 to 2001		
Year of monitoring	5 of 5		
Area of Project Impact	0.4 ha (1.13 ac)		
Type of Mitigation	Wetland restoration	Riparian restoration	Buffer restoration
Area of Mitigation	0.1 ha (0.4 ac)	0.03 ha 0.09 ac)	0.2 ha (0.56 ac)

Success Standards

Success standards contained in the *Wetland Restoration Plan SR 100 Construction Project, Ilwaco, Washington* (Ecological Landscape Services and EMCON 1996) were qualitatively evaluated. The complete text of the success standards is presented in Appendix C.

Success Standard 1

By year five, the restored wetland area with apparent wetland conditions should be at least 0.16 ha (0.4 ac) in size.

Success Standard 2

By year five, the restored wetland area is inundated by salt water at the same rate of occurrence as adjacent undisturbed wetland areas.

Success Standard 3

By year five, the total areal cover of native emergent and/or scrub-shrub wetland vegetation should be at least 75 percent in the restored wetland area.

Success Standard 4

By year five, in the restored wetland area, the total areal cover of undesirable non-native vegetation, including (*Phalaris arundinacea*) reed canary grass, *Spartina alterniflora* (smooth cordgrass), and *Iris pseudacorus* (yellow iris), will not exceed 5 percent.

Success Standard 5
By year five, total areal cover of native upland and/or riparian vegetation in the upland island habitat area should be at least 50 percent.

Success Standard 6
By year five, total areal cover of undesirable non-native vegetation in the upland island habitat, including reed canary grass, Himalayan blackberry, and evergreen blackberry, will not exceed 5 percent.

Success Standard 7
By year five, the total areal cover of native shrub and/or tree species, over meter in height, in the riparian zones will be at least 50 percent within a 10 foot wide zone immediately west of the restored wetland boundary and within a five foot wide zone on the west, north, and south sides of the upland habitat island.

Success Standard 8
By year five, total areal cover of undesirable non-native vegetation, including reed canary grass, Himalayan blackberry, and evergreen blackberry, should not exceed 5 percent in the riparian zone.

Success Standard 9
By year five, the total areal cover of native upland and/or riparian vegetation should be at least 75 percent in the upland buffer zone.

Success Standard 10
By year five, the total areal cover of undesirable non-native vegetation, including reed canary grass, Himalayan blackberry, and evergreen blackberry should not exceed 5 percent of either area in the upland buffer zone.

Methods
Due to the fragile vegetation in the wetland zone, quantitative monitoring was not conducted. To address the above success standards, photographs and detailed site sketches and notes were obtained. Values provided in this report are qualitative, based on ocular estimates. Seven photographs are included in this report to document the condition of the site.[8]

Each of the zones was delineated using a Global Positioning System (GPS) to verify acreages specified in first year success standards.

Results and Discussion:
Based on fifth year qualitative monitoring and photography, the SR 100 Ilwaco Restoration Project is developing as intended. Details of the development of each zone are presented below.

[8] More than 30 additional photographs are maintained in program files.

Wetland Restoration Zone:
The wetland restoration zone is a well-established plant community composed of species consistent with the adjacent undisturbed wetlands. Representative species in the restored wetland are comparable to those in the adjacent undisturbed wetland as shown in Table 1 below. *Typha angustifolia* (narrow-leaf cattail) is concentrated near the base of the riparian zone. Effective restoration of this area is evidenced by the fact that the boundary between it and the existing wetland is nearly indistinguishable (Figure 8).

Table 1. SR 100 Ilwaco Comparison of Restored and Undisturbed Wetlands 2001

Scientific Name	Common Name	Restored Wetland	Undisturbed Wetland
Carex lyngbyei	Lyngby's sedge	**X**	**X**
Argentina anserina	silverweed cinquefoil	**X**	**X**
Senecio serra	tall ragwort	**X**	**X**
Agrostis gigantea	redtop	**X**	**X**
Juncus balticus	Baltic rush	**X**	**X**
Festuca sp.	fescues	**X**	**X**
Rumex aquaticus	western dock	**X**	
Typha angustifolia	narrow-leaf cattail	**X**	

Figure 8. SR 100 Ilwaco Mitigation Site (August 2001).

Acreage results from delineation with GPS show that the area of the wetland restoration area is 0.35 acres. The difference between this and the required 4.0 acres is probably best explained by the difficulty there was in distinguishing the boundary between the pre-existing areas and the restored areas. A qualitative evaluation by program staff indicates that the restoration is successful and according to plan.

Success Standard 2 requires salt-water inundation at the same rate of occurrence as the adjacent undisturbed wetland. A channel leads from the open water to the base of the habitat island (Figure 9). Measurements taken with a refractometer in 1999 consistently showed water in the restoration zone within one part per thousand of the adjacent areas. The saltwater tolerant vegetation on site also suggests that saltwater influx is occurring at sufficient levels.

Figure 9. Tidal Channel near Upland Habitat Island (May 2001)

Success Standard 3, requiring 75% aerial cover of native vegetation in the restored wetland, was met in the third monitoring year. Native vegetation cover has not noticeably changed in subsequent monitoring years. Native species *T. angustifolia*, and *C. lyngbyei* are shown in the restored wetland in Figure 10.

Figure 10. Ilwaco Wetland Restoration Zone (Aug 2001).

Habitat Island Zone:
The habitat island zone also appears to have been successfully established (Figure 11). Based on visual estimates, the native plant community provided more than the 50% aerial cover required by Success Standard 5 in the third monitoring year, and has continued to develop since then. Components of this community include *Alnus rubra* (red alder), *Sambucus racemosa* (red elderberry), and *Rubus spectabilis* (salmonberry).

Figure 11. Cover on Upland Habitat Island (2001).

Riparian Zones:
Success Standard 7 requires two riparian zones with greater than 50% aerial cover provided by native trees and shrubs greater than 1 meter tall. The riparian zone at the base of the upland was to be 10 feet wide, and the riparian zone around the upland island habitat 5 feet wide. *Alnus rubra* and *Salix hookeriana* provided nearly 100% cover within the indicated widths in both riparian zones (Figure 12). These observations suggest the riparian zones have developed as intended.

Figure 12. Alder in Riparian Zone (August 2001).

Upland Buffer Zone:
In the upland buffer zone, slope stabilization by the erosion control mix has been successful, however, establishment of woody plantings on the steep upland slope has been difficult. Mortality has been high after both the original planting and a subsequent re-planting event. *Rubus spectabilis, Picea sitchensis,* and *Tsuga heterophylla* were re-

Figure 13. Upland Buffer (May 2001).

planted again in 2001. Survival was estimated to be about 70%. The part of the buffer adjacent to SR 100 has recently established *Picea sitchensis* (Sitka spruce), and *Tsuga heterophylla* (western hemlock) shown in Figure 13. Non-native *Ranunculus repens* (creeping buttercup)*, Vicia* species (vetches) and *Trifolium* species (clovers) dominate this part of the slope. Further down the slope, the upland buffer is dominated by native *Equisetum* species (horsetails) to 1m tall. *A. rubra* volunteers are also becoming established in this area. Cover in the part of the upland buffer near the riparian zone is provided by dense *A. rubra*. Though it appears that native cover is somewhat less than the 75% cover requirement (Success Standard 9) this standard should be achieved in the next year or so as replanted native woody plants continue to grow.

Objective B in the mitigation plan requires that 0.075 acres upland island habitat be created, and delineation data indicates this zone is 0.14 acres. Objective C: requires that 0.036 acres riparian zone be created, and delineation data indicates this zone is 0.15 acres. Objective D: requires that 0.56 acres upland buffer be created, and delineation data indicates this zone is 0.61 acres.

Erosion in the vegetated swale leading to the freshwater wetland has not been observed in any of the five years of monitoring conducted on this site, thus, satisfying conditions specified in Objective E of the mitigation plan (Figure 14).

Figure 14. Base of the vegetated swale (August 2001).

Six horizontal (or root wad) and one vertical habitat structures were counted in the upland buffer (Figure 15). An additional 9 were present in the wetland restoration area (see also Figures 8, 11, 12, and 14).

Figure 15. Habitat Structure on Upland Island (2001).

Success Standards 4, 6, 8, and 10 address undesirable vegetation in each of the zones. Ocular estimates of cover by undesirable vegetation are 5% or less in all zones except the habitat island. In the wetland restoration zone these species include *Iris pseudacorus* (yellow flag) and *Lythrum salicaria* (purple loosestrife). Hand weeding throughout the monitoring period has kept invasive cover below threshold levels in these zones. The combined cover provided by *Phalaris arundinacea* (reed canarygrass), *Cirsium vulgare* (bull thistle), and *I. pseudacorus* is just under 10% on the upland habitat island.

SR 500 Andresen Road, Clark County

The following report summarizes project activities completed by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program at the SR 500 Andresen Road mitigation sites in summer 2001. Monitoring activities included vegetation surveys and a qualitative assessment of the site with respect to Year 5 Success Standards (2001).

Site Information

Site Name	Andresen Road	
Project Names	SR 500 Andresen Road Interchange	
Permit Number	93-4-00157	
Permitting Agency	USACOE	
Location	Clark County	
Town/Section/Range	T.2N/R.2E/S.35 corner of Sections17, 18, 19, and 20,	
Monitoring Period	1997 to 2001	
Year of monitoring	5 of 5	
Area of Impact	3.56 ha (8.8 ac)	
Type of Mitigation	Creation	Enhancement
Area of Mitigation	3.83 ha (9.48 ac)	0.97 ha (2.39 ac)

Success Standards and Sampling Objectives

Fifth year success standards below were taken from *SR 500 Andresen Road Interchange Detailed Wetland Mitigation Plan* (Aberle 1993). Success standards are the same for each of the four quadrants comprising this mitigation site. Companion sampling objectives follow where appropriate. The complete text of the success standards is presented in Appendix D.

Success Standard 1

Buffer has 75-80% survival of native species. [9]

Success Standard 2

Each wetland will have at least 500-1,000 linear feet of edge between scrub-shrub and emergent vegetation.

Success Standard 3

Buffer width will average between 10-50 feet.

Additional Permit Requirement (Ecology 1993):

Six habitat structures, such as downed logs, snags, root wads, brush piles, or perch poles shall be placed in each of the four wetland mitigation quadrants.

[9] Plants that die are typically not recognizable by the fifth year of monitoring. Other factors such as natural recruitment and replanting also confound survival results if measured long after initial plant establishment. Survival estimates are typically not reported after the first year of monitoring.

Success Standard 4
Each wetland has 50-75% cover by scrub-shrub vegetation.

Sampling Objective 4
To be 80% confident the mean aerial cover estimate for scrub-shrub vegetation in the wetland is within 20% of the true value at the SR 500 Andresen Road mitigation site in 2001.

Success Standard 5
Scrub-shrub vegetation is dominated by 90% native species.

Sampling Objective 5
To be 80% confident the mean aerial cover estimate for native scrub-shrub vegetation (Cooke 1997) is within 20% of the true value in the wetland at the SR 500 Andresen Road mitigation site in 2001.

Success Standard 6
Each wetland has 5-10% cover by forested vegetation.

Sampling Objective 6
To be 80% confident the mean aerial cover estimate for tree species (Cooke 1997) in the wetland zone is within 20% of the true value at the SR 500 Andresen Road mitigation site in 2001.

Success Standard 7
Each wetland has 75-80% cover by emergent vegetation. [10]

Sampling Objective 7
To be 80% confident the mean aerial cover estimate for FAC and wetter herbaceous vegetation in the wetland zone is within 20% of the true value at the SR 500 Andresen Road mitigation site in 2001.

Success Standard 8
Emergent wetland areas are dominated by 80-90% native species.

Sampling Objective 8
To be 80% confident the mean aerial cover estimate for native herbaceous vegetation in the emergent wetland is within 20% of the true value at the SR 500 Andresen Road mitigation site in 2001.

[10] Emergent vegetation is defined in Year 3 Performance Standards for Objective 1 as all species with a wetland indicator status of facultative or wetter (Aberle, 1993).

Contingency
Attempts will be made to limit the spread of exotic species and they will not be allowed to dominate the site. A weed control program will be implemented if more than 10% of the wetland is invaded by invasive exotic species

Sampling Objective
To be 80% confident that the mean aerial cover estimate for invasive species at the SR 500 Andresen mitigation site is within 20% of the true value in 2001.

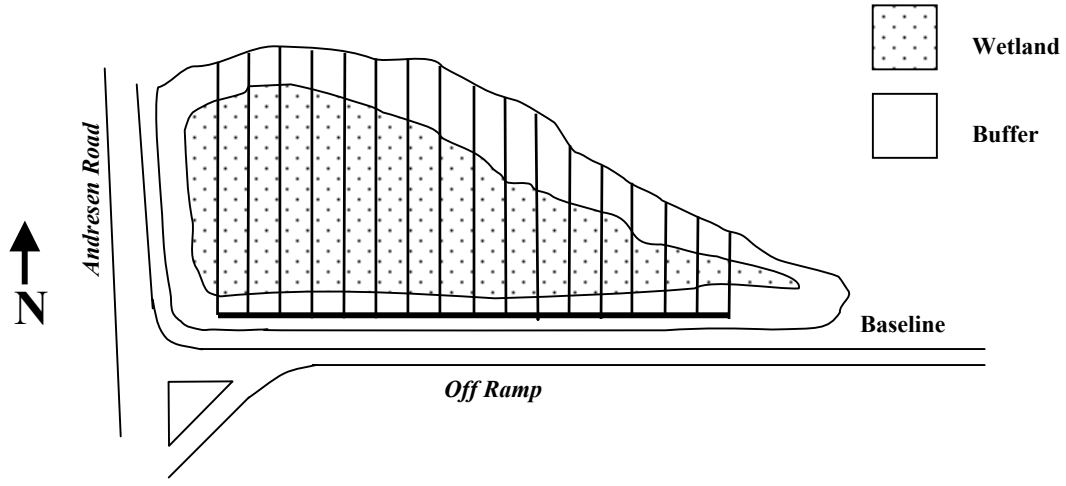
Methods
In each of the four quadrants of the SR 500 Andresen Road mitigation site, the following tasks were performed.

- A qualitative assessment was conducted to describe the condition of the buffer areas (Success Standard 1).
- The edges between the scrub-shrub and emergent vegetation were measured with a meter tape (Success Standard 2).
- Measurements were taken to calculate a rough average width of the buffer areas (Success Standard 3).
- Habitat structures and perch poles were counted (Additional Permit Requirement).

The sampling design strategy for the northeast quadrant described below provides an example of how requirements were addressed in the four quadrants.

Northeast Quadrant:
To conduct sampling of the vegetative community, a baseline was established along the southern boundary of the site. Twenty-three sampling transects were extended perpendicular to the baseline using a systematic random sampling method (Figure 16). Both line-segment sample units and point-line sample units were randomly located along sampling transects to measure woody and herbaceous vegetative attributes respectively.

Figure 16. Northeast Quadrant Mitigation Site Sampling Design Sketch (2001)



To assess cover of scrub-shrub and forest species in the wetland, 10-meter line-segment sample units were used for data collection. Data were collected on a total of 97 sample units (Success Standards 4, 5, and 6).

Emergent vegetative attributes in the wetland were also evaluated using 10-meter point-line sample units (20 points each). Data were collected on a total of 97 sample units (Success Standards 7 and 8).

To address the invasive species threshold in the Contingency, 20-meter point-line sample units (40 points each) were used. Data were collected on 76 sample units.

Results and Discussion:

Not all success standards were achieved in 2001 for the four quadrants comprising the SR 500 Andresen Road wetland mitigation site. However, these mitigation areas have developed well in many respects. Each of the quadrants features a scrub-shrub component that blends into native emergent communities and open water areas. Structural and species diversity in these areas is markedly higher than the degraded project impact areas composed primarily of *Phalaris arundinacea* (reed canarygrass) monocultures. The provision of wildlife habitat is evidenced by a diverse community of wildlife documented on site including many passerine and wetland-dependant birds species.[11] In general, vegetation has not developed as intended in the buffer areas. Mortality of plantings during initial plant establishment, and subsequent slow development of planted and replanted material are two contributing factors. Region staff are developing a plan for remediation in the buffer areas to ensure long term viability of the wetland sites. This plan will include replanting as necessary in each of the buffer areas, weed control, and retrofitting the existing drip irrigation systems to aid in plant establishment. Specific monitoring results for each quadrant follow.

[11] Wildlife data can be obtained from the WSDOT Monitoring Program office.

Northeast Quadrant:

SR 500 Andresen Road	Success Standard	2001 Results	Management Activities
Northeast Quadrant	>75% survival of native species in buffer	85-90% (qualitative)	
	500-1000 linear feet edge between scrub-shrub and emergent	840 feet	
	buffer width average 10-50 feet	26 feet	Replanting, irrigation
	6 habitat structures	6 root wads	
	>50% cover by scrub/shrub vegetation in wetland	12% (CI 0.80 ± 0.25)	Replanting
	>90% native scrub-shrub species in wetland (relative cover)	100% (relative cover)	
	>5% cover by forest vegetation in wetland	<1% (qualitative)	Replanting
	>75% cover by emergent vegetation in wetland	66% (CI 0.95 ± 0.07)	
	>80% native herbaceous species in wetland (relative cover)	86% (relative cover)	
	Contingency <10% cover by invasive exotic species	12% (CI 0.80 ± 0.22)	Weeding

Buffer areas are developing slowly in this quandrant. Marginal soil conditions and summer drought are two probable contributing factors. Plant survival appears to be relatively good in this quadrant, however, and replanting does not appear to be necessary (Success Standard 1).

The length of edge between the emergent and scrub-shrub zones was measured to be 256 meters (840 ft), achieving the 500-1000 foot requirement in Success Standard 2.

Buffer width measurements taken at 45 locations around the wetland ranged between 3 and 21 meters with an average width of 8 meters (26 ft). These values suggest the required 10 to 50 foot buffer width has been achieved (Success Standard 3).

Habitat structures were documented on site satisfying the Additional Permit Requirement (Ecology 1993).

The mean aerial cover estimate of all scrub-shrub species in the wetland is 12% (CI 0.80 ± 0.25). This estimated value is considerably lower than the 50% cover requirement in Success Standard 4. All of this cover, however, is provided by native scrub-shrub species. The resultant relative cover estimate of native shrub-scrub species in the wetland is 100% exceeding the 90% requirement in Success Standard 5.

Thuja plicata (western red cedar) was the only tree species encountered on line-segment sample units. Its cover is estimated at less than 1%, not achieving the 5% requirement in Success Standard 6.

The mean aerial cover estimate of cover of FAC and wetter herbaceous species in the wetland is 66% (CI 0.95 ± 0.07). This estimated value approaches the requirement of 75% in Success Standard 7.

The mean aerial cover estimate for all herbaceous species in the wetland is 71% (CI 0.99 ± 0.10). The mean aerial cover estimate of *native* herbaceous species in the wetland is 61% (CI 0.95 ± 0.09). Thus, the relative cover by native species is estimated at 86% exceeding the 80% requirement specified in Success Standard 8. *Typha latifolia*, (broadleaf cattail), *Schoenoplectus tabernaemontani*, (soft-stem bulrush), and *Juncus effusus* (soft rush) are the dominant species in the wetland area.

The mean aerial cover estimate of invasive species in the northeast quadrant is 12% (CI 0.80 ± 0.22). This estimated value is higher than the 10% threshold specified in the contingency. *Rubus armeniacus* (Himalayan blackberry) contributes the greatest amount out of this cover with *Cytisus scoparius* (Scotch broom), *P. arundinacea*, *Dipsacus sylvestris* (Fuller's teasel), *Hypericum perforatum* (common St. Johnswort), *Leucanthemum vulgare* (oxeye daisy), *Lythrum salicaria* (purple loosestrife) *Cirsium arvense* (Canada thistle), and *Cirsium vulgare* (bull thistle) also present on site at low levels.

Northwest Quadrant:

SR 500 Andresen Road	Success Standard	2001 Results	Management Activities
Northwest Quadrant	>75% survival of native species in buffer	Low*	Replanting, irrigation
	500-1000 linear feet edge between scrub-shrub and emergent	689 feet	
	buffer width average 10-50 feet	62 feet	Replanting, irrigation
	6 habitat structures	6 on site	
	>50% cover by scrub/shrub vegetation in wetland	21% (CI 0.80 ± 0.30)	Replanting
	>90% native scrub-shrub species in wetland (relative cover)	100% (relative cover)	
	>5% cover by forest vegetation in wetland	none	Replanting
	>75% cover by emergent vegetation in wetland	94% (CI 0.99 ± 0.05)	
	>80% native herbaceous species in wetland (relative cover)	66% (relative cover)	
	Contingency <10% cover by invasive exotic species	27% (CI 0.80 ± 0.30)	Weeding

The buffer has not developed as intended in this quadrant (Success Standard 1). Plant mortality and slow plant development have probably resulted from marginal soil conditions and summer drought. Replanting with drip irrigation is planned for the spring of 2002 in the buffer areas of this quadrant to ensure the long term integrity of the wetland.

The length of edge between the emergent and scrub-shrub zones was measured to be 210 meters (689 feet), achieving the 500-1000 foot requirement in Success Standard 2.

Twenty-five buffer width measurements ranged between 16.5 and 23 meters (54.1 to 75.5 feet), with an average of about 19 meters (62 feet). These values are more than the required 10 to 50 feet achieving Success Standard 3.

Habitat structures were documented on site satisfying the Additional Permit Requirement (Ecology 1993).

* Plants that die are typically not recognizable by the fifth year of monitoring. Other factors such as natural recruitment and replanting also confound survival results if measured long after initial plant establishment. Planting survival in the buffer in this quadrant was considered to be unsatisfactory. Replanting is scheduled for the spring of 2002.

The mean aerial cover estimate of all scrub-shrub species in the wetland is 21%(CI 0.80 ± 0.30). This estimated value is lower than the 50% cover requirement in Success Standard 4. All of this cover, however, is provided by native scrub-shrub species. Consequently, the relative cover estimate of native shrub-scrub species in the wetland is 100% exceeding the 90% requirement in Success Standard 5.

No tree species were identified on 30 line-segment sample units in the wetland, thus the 5% requirement in Success Standard 6 was not achieved.

The mean aerial cover estimate of FAC and wetter herbaceous species in the wetland is 94% (CI 0.99 ± 0.05). This estimated value exceeds the requirement of 75% in Success Standard 7.

The mean aerial cover estimate for all herbaceous species in the wetland is 94% (CI 0.99 ± 0.05), and the mean aerial cover estimate of native herbaceous species in the wetland is 62% (CI 0.90 ± 0.15). Thus, the relative cover by native species is 66% compared to the 80% requirement specified in Success Standard 8. *T. latifolia*, (broadleaf cattail), *S. tabernaemontani*, and *J. effusus* are the dominant species in the emergent zone.

The mean aerial cover estimate of invasive species on the northwest quadrant is 27% (CI 0.80 ± 0.30). This value exceeds the 10% requirement in the contingency.
C. scoparius, *P. arundinacea*, *D. sylvestris*, *H. perforatum*, *L. vulgare*, *C. arvense*, *R. armeniacus* and *L. salicaria* were identified on site.

Southwest Quadrant:

SR 500 Andresen Road	Success Standard	2001 Results	Management Activities
Southwest Quadrant	>75% survival of native species in buffer	Low*	Replanting, irrigation
	500-1000 linear feet edge between scrub-shrub and emergent	1,440 feet	
	buffer width average 10-50 feet	36 feet	Replanting, irrigation
	6 habitat structures	6 on site	
	>50% cover by scrub/shrub vegetation in wetland	20% (CI 0.80 ± 0.26)	Replanting
	>90% native scrub-shrub species in wetland (relative cover)	100% (relative cover)	
	>5% cover by forest vegetation in wetland	none	Replanting
	>75% cover by emergent vegetation in wetland	71% (CI 0.95 ± 0.10)	
	>80% native herbaceous species in wetland (relative cover)	75% (relative cover)	
	Contingency <10% cover by invasive exotic species	7% (CI 0.80 ± 0.26)	Weeding

A qualitative estimate of survival in the buffer shows that this area is not developing as intended (Success Standard 1). The plantings that have survived are sparse, occurring at low cover levels and therefore do not provide the intended wetland buffer. Replanting with drip irrigation is planned for the spring of 2002 in the buffer areas of this quadrant to ensure the long term integrity of the wetland.

The length of edge between the emergent and scrub-shrub zones was measured to be 439 meters (1440 feet), exceeding the 500-1000 foot requirement in Success Standard 2.

Forty buffer width measurements ranged between and 19 meters (3 to 62 feet), with an average of about 11 meters (36 feet). These values fall within the required range of between 10 to 50 feet (Success Standard 3).

Habitat structures were documented on site satisfying the Additional Permit Requirement (Ecology 1993).

*Plants that die are typically not recognizable by the fifth year of monitoring. Other factors such as natural recruitment and replanting also confound survival results if measured long after initial plant establishment. Planting survival in the buffer in this quadrant was considered to be unsatisfactory. Replanting is scheduled for the spring of 2002.

The mean aerial cover estimate of all scrub-shrub species in the wetland is 20% (CI 0.80 ± 0.26). This estimated value is considerably lower than the 50% cover requirement in Success Standard 4. All of this cover, however, is provided by native scrub-shrub species. Consequently, the relative cover estimate of native scrub-shrub species in the wetland is 100% exceeding the 90% requirement in Success Standard 5.

There were no tree species observed on line-segment sampling units in the wetland, thus the 5% requirement addressing forested cover in the wetland for Success Standard 6 was not achieved. Tree species do occur at low cover levels in the upland buffer.

The mean aerial cover estimate of FAC and wetter herbaceous species in the wetland is 71% (CI 0.95 ± 0.10). This estimated value is close to meeting the requirement of 75% in Success Standard 7.

The mean aerial cover estimate of all herbaceous species in the wetland is 73% (CI 0.95 ± 0.07), and the mean aerial cover estimate of native herbaceous species in the wetland is 55% (CI 0.95 ± 0.10). Thus, the relative cover by native species is 75% compared to the 80% requirement specified in Success Standard 8. *T. latifolia*, *S. tabernaemontani*, and *J. effusus* are the dominant species in the emergent zone.

The mean aerial cover estimate of invasive species on the Southwest quadrant is 7% (CI 0.80 ± 0.26), which is just under the 10% threshold for weed control program initiation specified in the Contingency. Invasive species encountered during sampling include: *C. scoparius*, *P. arundinacea*, *D. sylvestris*, *H. perforatum*, *L. vulgare*, *C. arvense*, *R. armeniacus*, and *L. salicaria* was found in a few places. *R. armeniacus* was observed to be invading from south fenceline.

Southeast Quadrant:

SR 500 Andresen Road	Success Standard	2001 Results	Management Activities
Southeast Quadrant	>75% survival of native species in buffer	Low*	Replanting, irrigation
	500-1000 linear feet edge between scrub-shrub and emergent	994 feet	
	buffer width average 10-50 feet	41 feet	Replanting, irrigation
	6 habitat structures	6 on site	
	>50% cover by scrub/shrub vegetation in wetland	8% (CI 0.80 ± 0.35)	Replanting
	>90% native scrub-shrub species in wetland (relative cover)	99% (relative cover)	
	>5% cover by forest vegetation in wetland	<1% (qualitative)	Replanting
	>75% cover by emergent vegetation in wetland	51% (CI 0.90 ± 0.11)	
	>80% native herbaceous species in wetland (relative cover)	79% (relative cover)	
	Contingency <10% cover by invasive exotic species	12% (CI 0.80 ± 0.31)	

The buffer has not developed as intended in this quadrant (Success Standard 1). Plant mortality and slow plant development have probably resulted from marginal soil conditions and summer drought. Replanting with drip irrigation is planned for the spring of 2002 in the buffer areas of this quadrant to ensure the long term integrity of the wetland.

The length of edge between the emergent and scrub-shrub zones was measured to be 303 meters (994 feet). This value is within the 500-1000 linear feet required in Success Standard 2.

Forty-five buffer width measurements ranged between 6.5 and 21 meters (21 to 69 feet), with an average of 12.5 meters (41 feet). The average of these values is at the high end of the required range of 10 to 50 feet (Success Standard 3).

Habitat structures were documented on site satisfying the Additional Permit Requirement (Ecology 1993).

* Plants that die are typically not recognizable by the fifth year of monitoring. Other factors such as natural recruitment and replanting also confound survival results if measured long after initial plant establishment. Planting survival in the buffer in this quadrant was considered to be unsatisfactory. Replanting is scheduled for the spring of 2002.

The mean aerial cover estimate of all scrub-shrub species in the wetland is 8% (CI 0.80 ± 0.35). This estimated value is considerably lower than the 50% cover requirement in Success Standard 4. Cover provided by *C. scoparius,* the only non-native woody species encountered on sample units, is 0.05% (CI 0.80 ± 40.x). Consequently, the relative cover estimate of native scrub-shrub species in the wetland is 99% exceeding the 90% requirement in Success Standard 5. The existing scrub-shrub area is dense and well developed, but does not entirely surround the pond. Additional cover may develop from recently planted willow stakes in undeveloped areas.

T. plicata and *Populus balsamifera* (black cottonwood) were tree species encountered on line-segment sample units. Cover provided by these species is estimated at less than 1% (CI 0.80 ± 0.50), not achieving the 5% requirement in Success Standard 6.

The mean aerial cover estimate of FAC and wetter herbaceous species in the wetland is 51% (CI 0.90 ± 0.11). This is less than the requirement of 75% specified in Success Standard 7. *S. tabernaemontani*, and *T. latifolia* were the dominant emergent species in the wetland. The 75% cover requirement may be achieved later in the growing season as annual cover increases throughout the summer.

The mean aerial cover estimate of all herbaceous species in the wetland is 54% (CI 0.90 ± 0.11), and the mean aerial cover estimate of *native* herbaceous species in the wetland is 43% (CI 0.90 ± 0.13). Thus, the relative cover by native species is 79% compared to the 80% requirement specified in Success Standard 8. *T. latifolia*, *S. tabernaemontani*, and *J. effusus* are the dominant species in the emergent zone.

The mean aerial cover estimate of invasive species on the Southeast quadrant is 12% (CI 0.80 ± 0.31). This estimated value is higher than the 10% threshold stated in the contingency. Species providing this cover include: *C. scoparius*, *P. arundinacea*, *D. sylvestris*, *H. perforatum*, *L. vulgare*, *C. arvense*, and *R. armeniacus*.

Management Activities:
Region staff are developing a plan for remediation in the buffer areas to ensure long term viability of the wetland sites. This plan will include replanting as necessary in each of the buffer areas, weed control, and retrofitting the existing drip irrigation systems to aid in plant establishment. All new plantings will be mulched to limit competition with herbaceous vegetation. Weed control efforts are scheduled for the spring and summer of 2002.

SR 504 Kid Valley, Cowlitz County

Summary

Site Name	Success Standard	2001 Results	Management Activities
SR 504 Kid Valley	Emergent wetland areas will have ≥ 50% areal cover	53% (CI 0.90 ± 0.15) and 33% (CI 0.80 ± 0.15)	
	≥ 15% areal cover of woody vegetation within scrub-shrub wetland	Not evaluated[12]	Re-planted, elk fencing
	Evidence of ponding or saturated soils	Ponding present	
	Planted trees and shrubs show measurable growth	Not evaluated	Re-planted, elk fencing
	Five logs and/or root wads	Present	
	Raptors, passerines and waterfowl use the site	Present	
	<20% reed canary grass	<2% (qualitative)	

The following report summarizes project activities completed by the Washington State Department of Transportation (WSDOT) Wetland Monitoring Program at the SR 504 Kid Valley mitigation site during the summer of 2001. Monitoring activities include vegetation surveys and a qualitative assessment of the site with respect to Year 3 Success Standards (2001).

Site Information

Site Name	SR 504 Kid Valley
Project Name	SR 504 Kid Valley Road to Maple Flats
Permit Number	98-4-00050
Permitting Agency	USACOE
Location	Kid Valley Road off Toutle River
Monitoring Period	1999-2003
Year of Monitoring	3 of 5
Area of Impact	0.20 ha (0.48 ac) and remedial for Toutle River site
Type of Mitigation	Created wetland
Area of Mitigation	0.77 ha (1.90 ac)

Success Standards and Sampling Objectives

Third year success standards listed below were excerpted from the *SR 504 Kid Valley to Maple Flats Vicinity Detailed Wetland Mitigation Plan* (Scott and Winkley 1998).

[12] Woody species cover was not assessed this year because the site was completely replanted in the spring of 2001.

Companion sampling objectives follow where appropriate. A complete text of the success standards for this site is presented in Appendix E.

Success Standard 1
The emergent wetland areas will have ≥ 50% areal cover, which is composed of a minimum of three FAC, FACW or OBL species.

Sampling Objective 1
To be 80% confident the herbaceous species cover estimate in the emergent wetland areas at the SR 504 Kid Valley mitigation site in 2001 is within 20% of the true value.

Success Standard 2
There is ≥ 15% areal cover of woody vegetation within the areas designated as scrub-shrub wetland.

Success Standard 3
There is evidence of ponding or saturated soils in the newly constructed part of the wetland for 12 percent of the growing season. Evidence of ponding or saturation may include any of the hydrologic indicators of such conditions identified in the U.S. Army Corps of Engineers wetland delineation manual (Environmental Laboratory 1987).

Success Standard 4
The planted trees and shrubs will show measurable growth between annual samplings times based on plant height or width, as shown in photo documentation.

Success Standard 5
A minimum of five logs and/or root wads will be found on the site during Year One and will remain on the site throughout the monitoring period.

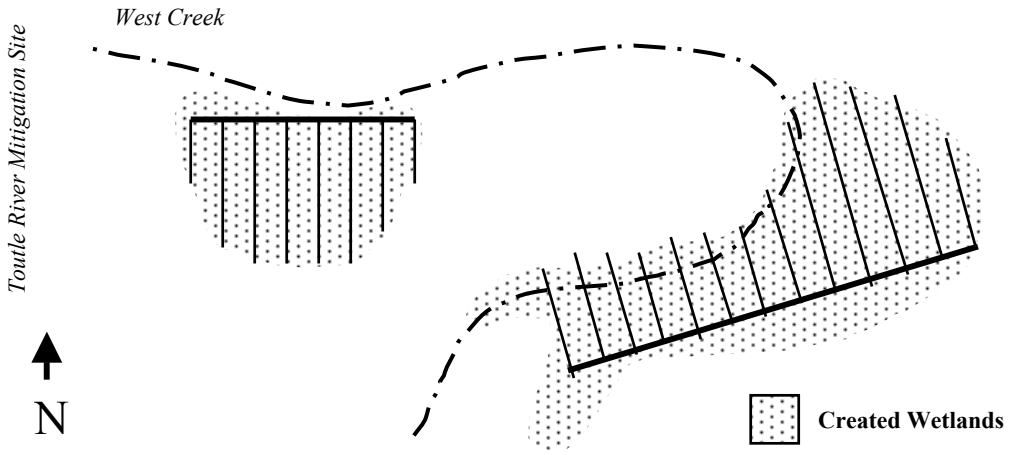
Success Standard 6
Raptors, passerines and waterfowl will be observed using the site for roosting, nesting or foraging habitat within the five year monitoring period.

Contingency
Attempts will be made to limit the spread of exotic, invasive species, which will not be allowed to dominate the site. Noxious weeds will be eliminated immediately if found occurring on the site, before large populations can establish. A weed control program will be implemented if more than 20% of the vegetated areas are covered with reed canary grass before that threshold is met.

Methods

In order to evaluate the vegetative community, two parallel baselines were located on either side of West Creek. The eastern baseline is at the southeast edge of the excavated wetland and the western baseline is in a similar position on the other side of West Creek, west of the south weir. A total of 45 temporary sampling transects were placed perpendicular to the baselines using a systematic random sampling method (Figure 20).

Figure 17. SR 504 Kid Valley Mitigation Site Sampling Design Sketch (2001)



To evaluate Success Standard 1, herbaceous plant species cover data were collected from 22 randomly positioned point-line sample units in the eastern area, and 16 randomly positioned point-line sample units in the western area. Each sample unit consisted of 80 points spaces at half-meter intervals.

Sample size analysis was conducted to determine if sufficient sampling had been completed to achieve the sampling objectives. The following equation was used to perform this analysis (Elzinga et al. 1998).

$$n = \frac{(z)^2(s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level[13]
n = unadjusted sample size

Woody species cover (Success Standard 2) was not evaluated this year because the prior elk damage was so extensive that nearly all woody trees and shrubs are new plantings providing little cover.

[13] In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

To evaluate hydrology in Success Standard 3, evidence of ponding or saturation, and the U.S. Army Corps of Engineers hydrologic field indicators were recorded during site visits.

Photographs were taken during site visits to document the condition of woody plantings on site (Success Standard 4)

Presence of habitat structures was recorded during the vegetation monitoring site visit. (Success Standard 5).

To evaluate bird use of the site (Success Standard 6), 4 bird surveys were conducted at the mitigation site between May and July. Species richness and relative abundance were recorded. Incidental observations of raptors, passerines and waterfowl were recorded.

Species diversity indices (H) were calculated from bird survey data using the Shannon-Wiener function (Krebs 1999). A mean species diversity index was calculated for 2001.

$$H' = -\sum_{i=1}^{s} (p_i)(\log p_i)$$

H' = index of species diversity
s = number of species
p_i = proportion of sample belonging to ith species

Cover provided by invasive species (Contingency) was qualitatively evaluated because the cover was so low and distributed at the edges of the site.

Results and Discussion

The mean aerial cover estimate for herbaceous FAC and wetter species in the eastern wetland area is 53% (CI 0.90 ± 0.15) (Figure 21). The mean aerial cover estimate for herbaceous FAC and wetter species in the western wetland area is 33% (CI 0.80 ± 0.15). Emergent vegetation is developing well in both areas. The 50% cover requirement (Success Standard 1) is met in the eastern area, and may be met next year in the western area. Native species *Eleocharis ovata* (ovate spikerush), *Ludwigia palustris* (marsh seedbox), *Carex obnupta* (slough sedge), and *Juncus acuminatus* (taper tip rush) contribute most of this cover.

Elk browse has made plant establishment nearly impossible in this site location. A fence was constructed around the site in the spring of 2001 to protect the new plantings shown in Figure 21. New woody plantings do not yet provide the 15% cover required in Success Standard 2.

Figure 18. SR 504 Kid Valley (July 2001)

Inundation to 15 cm (6 inches) was observed in the wetland areas in February 2001. In May 2001, the depth of inundation was up to 30 cm (12 inches). By July, the eastern wetland area had completely receded, and the western wetland was inundated to 10 cm (4 inches). These observations indicate that Success Standard 3 has been met (wetland hydrology present for 12% of the growing season).

There was no measurable growth between annual sampling times due to persistent elk browse (Success Standard 4).

Success Standard 5 requires five logs and/or root wads. Eleven were observed on the site.

Success Standard 6 requires use of the site by raptors, passerines and waterfowl. Raptors observed include Osprey, Turkey Vulture, Bald Eagle, and Sharp-shinned Hawk. Thirty-two passerine species were observed during our site visits in 2001, including the following wetland-dependent species: Red-winged Blackbird, Common Yellowthroat, and Belted Kingfisher. A female wood duck and four chicks observed on site demonstrates the site is being used by waterfowl. The shorebird Spotted Sandpiper, and wading birds Great Blue Heron and Virginia Rail, are other wetland-dependent species also documented on site. In addition, there are numerous bird boxes on the site, often observed with nesting swallows. These observations suggest the site is used by a diverse avian community.

Past weed control has limited cover of invasives on the site (estimated at less than 2% cover). A small patch of *Phalaris arundinacea* (reed canarygrass) is present on the north side of the west pond. *Cirsium* species, *Rubus laciniatus* (cutleaf blackberry), and *Cytisus scoparius* (Scotch broom) were also identified on site. The 20% invasive cover threshold has not been exceeded.

Management Activities

Elk repellent vials attached to planted woody species were not found useful in reducing browse damage. Subsequently, a fence to exclude elk was installed and damaged woody species were re-planted in spring 2001**.** Planting areas will be evaluated in the spring of 2002. Supplemental planting and weed control will be conducted in the fall of 2002 as necessary.

APPENDICES

Appendix A

SR 12 Maryhill Success Standards

The following excerpt is from the *Maryhill State Park Wetland Enhancement Agreement* (Smith and Pinnix, 1996). The plan makes two provisions for wetland establishment and monitoring.

Goals, Objectives and Standards of Success

1. If, in the opinion of WSDOT biologists, the Wetland Enhancement Area is not developing successfully, WSDOT shall develop and implement a remedial action plan.
2. At the completion of the three (3) year monitoring period WSDOT and State Parks will arrange for a joint site inspection. If it is determined that remedial action (such as replanting) is needed, WSDOT will remain responsible for the site until such remediation has been completed.

Appendix B

SR 12 Peters Road Success Standards

The following excerpt is from the *Peter's Road Vicinity Slide Repair Wetland Mitigation Plan* (Null et al. 1998). The standards addressed this year are identified in **bold** font. Other standards will be addressed in the indicated monitoring year.

Goals, Objectives and Standards of Success
Goals: The general goal of this wetland mitigation plan is two fold:

- Restore a non-wetland flood plain forest similar to what existed historically, and is currently present in the northwest portion of the property. This forest will eventually more than offset the functions lost at the impacted wetland.
- Reduce stream bank slumping by stabilizing with bioengineering techniques.

Objective #1: Riparian Forest – Restore at least 2.1 ha (5.3 ac) of pasture to a riparian forest on the Cowlitz River floodplain.

Standard of Success: Noxious Species

- **In any monitoring year except year ten, the combined aerial cover of noxious or invasive non-native species throughout the site will not exceed 15%. In year ten, this combined aerial cover will not exceed 10%. These plants include the following:**

  Cirsium vulgare (bull thistle)
  Cirsium arvense (creeping thistle)
  Xanthium strumarium (rough cocklebur)
  Rubus procerus (Himalayan blackberry)

Standards of Success: Tree and Shrub Plantings

- The first year following construction will have a minimum of 80% survival of the planted trees and shrubs with no less than 25% survivorship of each individual species.
- In the second year following construction, the site (all communities) will have at least 10% aerial vegetative cover from woody plants alone.
- In the fifth year following construction, the site (all communities) will have at least 40% aerial vegetative cover from woody plants alone.
- In the tenth year following construction, the site (all communities) will have at least 75% aerial vegetative cover from woody plants alone.

Objective 2: Stream bank Stabilization – Stabilize approximately 30 linear meters (100 linear feet) of river bank within WSDOT property of the mitigation site.

Standards of Success: Because this section of the river bank is on a bend where erosive conditions are dynamic and at times climactic, these standards may be difficult to achieve. Those that follow are predicated on the prepared area not being destroyed by a major flood event.

- In the first year following construction, at least 50% of all as-built planted material (live stakes and/or seedlings) in the bank stabilization area will have sprouted.
- In the second year following construction, the bank stabilization area will have at least 10% aerial vegetative cover from woody plants alone.
- In the fifth year following construction, the bank stabilization area will have at least 40% aerial vegetative cover from woody plants alone. Signs of erosion will be few to minimal or none.

In the tenth year following construction, the bank stabilization area will have at least 75% aerial vegetative cover from woody plants alone. Signs of erosion will be minimal to none.

Appendix C

SR 100 Ilwaco Success Standards

The following excerpt is from the *Wetland Restoration Plan SR 100 Construction Project, Ilwaco Washington* prepared by Ecological Landscape Services and EMCON, July, 1996 for WSDOT. The standards addressed this year are identified in **bold** font.

Goals, Objectives, and Standards of Success

Goals: As stated in the Wetland Restoration Plan (EMCON, 1996), the goal of the SR 100 Ilwaco mitigation site is to enhance establishment of the naturally sustainable communities within the dynamic conditions that will develop in the restoration area. The Wetland Restoration Plan (EMCON, 1996) addresses four zones and enhancements to one other area as follows:

- **Wetland Restoration Zone**: Restore the grade of a significant area of wetland and reestablish viable plant communities that will support wildlife. A dynamic mix of communities is expected that are adapted to fresh water, brackish water, or saltwater conditions. A part of this zone was previously restored by WSDOT.
- **Habitat Island Zone**: Create an upland habitat area within the wetland by leaving a remnant of landslide debris, existing deadfall trees, and vegetation.
- **Riparian Revegetation Zone**: Create a riparian zone along the edge of the restored wetland including part of the island.
- **Upland Buffer Zone**: Create an upland buffer zone for the wetland on the slope disturbed by the landslide and embankment of the excavated landslide material.
- **Freshwater Wetland Enhancement Area**: Enhance the freshwater wetland located just north of the restoration area by directing groundwater discharging from the drainage rock layer in the road fill to this area. This will also enhance the development of brackish and saltwater conditions in the Wetland Restoration Zone by directing a significant amount of fresh water away from the restored area.

Objective A: Provide approximately 0.16 ha (0.4 ac) of restored emergent wetland consistent with plant communities and hydrologic conditions that are present in adjacent undisturbed wetlands. The area will include a minimal grade to promote drainage and minimize ponding of water in the restoration area.

Performance Standard #1: **By year five, the restored area with apparent wetland conditions should be at least 0.16 ha (0.4 ac) in size**.

Performance Standard #2: **By year five, the wetland area is inundated by salt water at the same rate of occurrence as adjacent undisturbed wetland areas**.

Performance Standard #3: **By year five, the total areal cover of native emergent and/or scrub-shrub wetland vegetation should be at least 75 percent**.

Performance Standard #4: **By year five, the total areal cover of undesirable non-native vegetation, including (*Phalaris arundinacea*) reed canary grass, *Spartina alterniflora* (smooth cordgrass), and *Iris pseudacorus* (yellow iris), will not exceed 5 percent**.

Objective B: Provide approximately 0.032 ha (0.08 ac) of **upland island habitat**, including existing woody debris.

Performance Standard #1: By year one, the **upland island habitat** area will be at least 0.03 ha (0.075 ac) in size unless the area measured immediately after construction is smaller than 0.032 ha (0.08 ac).

Performance Standard #2: **By year five, total areal cover of native upland and/or riparian vegetation should be at least 50 percent**.

Performance Standard #3: **By year five, total areal cover of undesirable non-native vegetation, including *Phalaris arundinacea* (reed canary grass), *Rubus procerus* (Himalayan blackberry), and *Rubus laciniatus* (evergreen blackberry), will not exceed 5 percent**.

Objective C: Provide approximately 0.036 ha (0.09 ac) of **riparian zone** in areas immediately adjacent to the wetland restoration area.

Performance Standard #1: B**y year five, the total areal cover of native shrub and/or tree species, over meter in height, will be at least 50 percent within a 10 foot wide zone immediately west of the restored wetland boundary and within a five foot wide zone on the west, north, and south sides of the upland habitat island**.

Performance Standard #2: **By year five, total areal cover of undesirable non-native vegetation, including reed canary grass, Himalayan blackberry, and evergreen blackberry, should not exceed 5 percent.**

Objective D: Provide approximately 0.22 ha (0.56 ac) of **upland buffer** on the currently exposed slope west of the wetland restoration zone. **Upland buffer** zone will consist of area cut or filled with material excavated from the wetland restoration area. Area to be hydro-seeded initially to reduce erosion.

Performance Standard #1: By year one, the **upland buffer** zone should be at least 0.2 ha (0.5 ac) in size.

Performance Standard #2: By year one, the total areal cover of grass/clover erosion control species mix will be at least 75 percent.

Performance Standard #3: **By year five, the total areal cover of native upland and/or riparian vegetation should be at least 75 percent**.

Performance Standard #4: **By year five, the total areal cover of undesirable non-native vegetation, including reed canary grass, Himalayan blackberry, and evergreen blackberry should not exceed 5 percent of either area**.

Objective E: Provide vegetated bio-swale to conduct fresh water seeping from the reconstructed slope to the adjacent **freshwater wetland**.

Performance Standard #1: By year two, there is no evidence of soil erosion resulting from surface water flow within the bio-swale.

Objective F: Provide woody debris where possible to provide habitat for wildlife, without over-utilizing woody debris to the extent that it poses risks to newly planted vegetation, is unsightly, or discourages wildlife use.

Performance Standard #1: Following project construction, at least four horizontal logs or root wads occur within the upland buffer zone, west of the wetland restoration zone.

Appendix D

SR 500 Andresen Road Success Standards

The following excerpt is from the *SR 500 Andresen Road Interchange Detailed Wetland Mitigation Plan* (Aberle 1993). The standards addressed this year are identified in **bold** font.

STANDARDS OF SUCCESS

3. **Goals**

The goal of the Andresen Road wetland mitigation project is to create four self sustaining emergent and scrub-shrub wetlands that will be of higher value than the degraded uplands and reed canary grass monocultures they will replace. Each wetland basin will be similarly constructed and have the same general configuration and design. Wetland manageability and viability of each site will be enhanced by the establishment of upland buffer around each system. In general, the created wetland systems are expected to provide the following functions and values: wildlife habitat, food chain support, water storage and attenuation, and sediment and nutrient trapping.

Excavation and contour grading combined with vegetation establishment will be used to alter the existing site conditions from a predominantly grassland community to an emergent and scrub-shrub wetland interspersed with standing water and some small areas of forested wetland. This will result in an increase in habitat complexity from a single herbaceous layer to a wetland with multiple canopy layers and at least three wetland classes. The surrounding forested buffer will also provide habitat and protect the site from human intrusion and noise and glare associated with the highway.

4. **Objectives and performance standards**

The following objectives and performance standards establish specific criteria that will be used by WSDOT and regulatory agencies to measure the mitigation site's success. The objectives below specify the direct actions that are necessary to achieve the goal of the mitigation project. The performance standards provide the specific measurements used to evaluate whether the goals and objectives are being met.

Objective #1

Four wetland basins will be constructed that have vegetation structure and species diversity of higher quality when compared to the existing degraded wetland and uplands at the site.

Performance standards:

After 3 years:

1a. Each wetland has 75% survival of facultative or wetter species, or is supplemented or replaced by a native wetland plant community regenerating at 75% or greater cover.

1b. Three wetland classes, scrub-shrub, emergent and open water will be established within each wetland system.

After 5 years:

1c. Each wetland has 50-75% cover by scrub-shrub vegetation

1d. Each wetland has 75-80% cover by emergent vegetation

1e. Each wetland has 5-10% cover by forested vegetation

1f. Emergent wetland areas are dominated by 80-90% native species

1g. Scrub-shrub vegetation is dominated by 90% native species

Objective #2 Increase in wildlife habitat

Wildlife habitat will be upgraded by the addition of proposed native species plantings. This will result in an increase in vegetation structure, complexity and edge. As the mitigation site vegetation matures conditions of the site will change from simple system with one canopy layer to a more complex scrub-shrub and emergent wetland that exhibits multiple vegetation layers and an interspersion of wetland classes with open water areas.

Performance Standards

After 3 years:

An increase in wildlife habitat will be measured by the areal cover of woody vegetation and the number wetland classes. It is expected that the habitat structure will change from a single layer to multiple layers over time as trees and shrubs mature.

2a. Wetlands have 50-75% cover of scrub-shrub species

2b. Three wetland classes, scrub-shrub, emergent and open water will occur at each site

After 5 years:

2c. **Each wetland system will contain at least three wetland classes.**

2e. Each wetland will have at least 500-1,000 linear feet of edge between scrub-shrub and emergent vegetation.

Objective #3

Long term viability and manageability of the mitigation sites will be enhanced by the establishment of a buffer of native upland trees and shrubs around the majority of each wetland created.

After 3 years:

3a. Buffer has 50-75% survival of native species planted or is supplemented or replaced by native vegetation at 75% or greater cover.

After 5 years:

3b. **Buffer has 75-80% survival of native species.**

3c. Buffer width will average between 10-50 feet.

CONTINGENCY PLANS

5. If areal coverage of wetland plants is less than 50% after the fourth year, resource agencies will be consulted for advice on further measures to remedy the problems at the site. The monitoring program will be extended and such reasonable measures will be performed as are necessary to establish appropriate wetland vegetation. WSDOT will perform all reasonable measures considered necessary to establish and maintain a functioning wetland system.

6. **The mitigation plan is designed to utilize and promote the growth of native vegetation. Attempts will be made to limit the spread of exotic species and they will not be allowed to dominate the site. Noxious weeds, such as purple loosestrife will be eliminated immediately if found occurring on the site, before large populations can establish. A weed control program will be implemented if more than 10% of the wetland is invaded by invasive exotic species.**

Additional Permit Requirements:
Department of Ecology Water Quality Certification #93-4-0157, page 2, item 7.
In order to assist in attaining the performance standards of Objective #2, six habitat structures, such as downed logs, snags, root wads, brush piles, or perch poles shall be placed in each of the four wetland mitigation quadrants.

Appendix E

SR 504 Kid Valley Success Standards

The following goals, objectives and success standards are excerpted from the *SR 504 Kid Valley to Maple Flats Vicinity Detailed Wetland Mitigation Plan* (Scott and Winkley 1998). Success standards that apply to 2001 are identified in **bold** font. Other standards will be addressed in the indicated year.

GOALS, OBJECTIVES, AND PERFORMANCE STANDARDS

Goals

The goal of this wetland mitigation plan is to: 1) Replace major wetland functions lost due to project impacts; 2) Establish a self-sustaining, functional native wetland system that will provide flood storage and enhance water quality, habitat diversity, food chain support, and baseflow support along the NF Toutle River corridor; and 3) Create the 0.337 hectares (0.83 acres) of wetland required as remedial action for the existing mitigation site (SR 504-Green River to Coldwater Lake project). Excavation and contour grading combined with vegetation establishment will be used to create an expanded wetland system associated with the existing mitigation area. The site is expected to change from an upland grassland community to a structurally complex emergent and scrub-shrub wetland. In general, the created wetland will provide the following functions and values: wildlife habitat, food chain support, flood and stormwater storage and attenuation, and sediment and nutrient trapping.

Objectives and Performance Standards

Objective 1:

Replace wetland functions lost due to project impacts by creating at least 0.65 hectares (1.6 acres) of emergent and scrub-shrub wetland, of which 0.337 hectares (0.83 acres) satisfies remedial requirements, to produce a varied wetland system with vegetative structure and species diversity resembling natural systems.

Standards of Success for Objective 1:

At the end of the first year following construction:

a. At least two wetland classes, emergent and scrub-shrub, are established within the newly created wetland areas.

After 3 Years

b. The emergent wetland areas will have ≥ 50% areal cover, which is composed of a minimum of three FAC, FACW or OBL species

c. **There is ≥ 15% areal cover of woody vegetation within the areas designated as scrub-shrub wetland**.

After 5 Years

d. A minimum of 0.65 hectares (1.6 acres) of wetland will be created by the end of the monitoring period.

e. The emergent zones will have ≥ 80% areal cover by FAC, FAW or OBL species.
f. There will be at least 30% areal cover of woody vegetation in the areas designated as scrub-shrub wetland.
g. The combined areal cover of invasive species (reed canarygrass and Scot's broom) shall not exceed 20%.

Objective 2:
The vegetation plantings in wetland creation areas will succeed and become self-sustaining.

Standards of Success for Objective 2:

a. At least 80% of the plants initially planted will survive through the first growing season after planting
b. The planted trees and shrubs will show measurable growth between annual samplings times based on plant height or width, as shown in photo documentation.

Objective 3:
The hydrology on the site is successfully achieved by holding water for sufficient duration each spring (through May) to support hydrophytic vegetation.

Standards of Success for Objective 3:

a. Success with vegetation standards given in Objectives 1 & 2 will demonstrate success in producing adequate hydrology.
b. There is evidence of ponding or saturated soils in the newly constructed part of the wetland for 12 percent of the growing season. Evidence of ponding or saturation may include any of the hydrologic indicators of such conditions identified in the U.S. Army Corps of Engineers wetland delineation manual (Environmental Laboratory 1987).

Objective 4:
The created wetland areas will provide wildlife habitat for a variety of wetland dependent and other vertebrate species. Creation of habitat will focus on increasing both habitat diversity (number of habitat types present) and habitat complexity (number and extent of canopy levels).

Standards of Success for Objective 4:

a. Success with vegetation standards given in Objectives 1 & 2 will demonstrate success in producing wildlife habitat.
b. **A minimum of five logs and/or root wads will be found on the site during Year One and will remain on the site throughout the monitoring period.** As-built plans will show the final placement of downed logs and root wads in the created wetland areas.

c. Raptors, passerines and waterfowl will be observed using the site for roosting, nesting or foraging habitat within the five year monitoring period.

CONTIGENCY PLAN

Mitigation goals and objectives will be accomplished with successful native vegetation plantings and creation of 0.65 hectares (1.6 acres) of wetland and wildlife habitat. If monitoring results indicate that standards of success will not be met, a remedial action plan will be developed and implemented. In the event that percent coverage falls short of the stated performance standards, additional measures will be employed to assure the establishment of a viable wetland plant community. This may include planting additional stock or different plant species, grading, amending soils, or any other action deemed necessary by WSDOT wetland biologists and landscape architects. Any remedial actions deemed necessary for the success of the project will be coordinated with the U.S. Army Corps of Engineers personnel prior to implementation.

The mitigation plan is designed to utilize and promote the growth of native vegetation. Attempts will be made to limit the spread of exotic, invasive species, which will not be allowed to dominate the site. Noxious weeds will be eliminated immediately if found occurring on the site, before large populations can establish. A weed control program will be implemented if more than 20% of the vegetated areas are covered with reed canary grass before that threshold is met. The monitoring period will be extended until the performance standards are successfully met.

Glossary of Terms

Abundance (total) – the total number of individuals, cover, frequency of occurrence, volume, or biomass of a species, or group of species, within a given area.

Accuracy – the closeness of a measured or computed value to its true value.

Adaptive management – the process of linking ecological management within a learning framework (Elzinga et al. 1998).

Aerial cover – is the amount of ground covered by vegetation of a particular species or suite of species when viewed from above. Aerial cover is generally expressed as a percentage. This is typically obtained from point-line, point-frame, or line intercept data.

Areal estimates – are made using the mapped boundary of a feature as viewed from above. Areal estimates are a measure of area recorded as a number from 0 to 100, and not as a fraction or percent (Hruby et al. 1999).

Aquatic vegetation – includes submerged and rooted (*Elodea*, *Characeae*, *Myriophyllum*) or floating (non-rooted) plants (*Lemna, Azolla, Wolfia*). For compliance purposes, these plants are not included in cover estimates. Vascular, rooted, floating-leaved plants *are* included in cover estimates (e.g., *Nuphar, Potamogeton*).

Bare ground – an area that can support, but does not presently support vascular vegetation.

Confidence interval (CI) – is an estimate of precision around a sample mean. A confidence interval includes confidence level and confidence interval half-width. Expressed as: CI 0.80 ± 0.20.

Canopy cover – the coverage of foliage canopy (herbaceous or woody species) per unit ground area**.**

Community – a group of populations of species living together in a given place and time.

Cryptogam – any of the *Cryptogamia*, an old primary division of plants comprising those without true flowers and seeds including ferns, mosses, and thallophytes (algae, fungi, and lichen).

Density – the number of individuals, stems, or other counting unit per unit area.

Densitometer – a hollow T-shaped polyvinyl chloride (PVC) device that includes horizontal and vertical leveling and a mirror to locate a precise vertical point in space

either directly above or directly below the densitometer. Target vegetation intersecting the vertical line of sight through the instrument is recorded.
Herbaceous – with characteristics of an herb; an annual, biennial, or perennial plant that is leaflike in color or texture, and not woody.

Hydric soils – soils formed under the conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

Invasive – A plant that interferes with management objectives on a specific site at a specific point in time (Whitson et al. 2001).

Macroplot – usually refers to a relatively large sampling area in which sub-sampling will be conducted, often using quadrats and/or transects (Elzinga et al. 1998).

Open water – an area intended to be non-vegetated and permanently inundated as described in the site mitigation or planting plan.

Point frame – is a square or rectangular quadrat that consists of a set of identified points used to collect vegetation data.

Point Intercept Device – a tripod that contains a level and supports a rod that can also be leveled and then lowered vertically to intercept target vegetation at an identified point.

Point-line – linear series of points comprising a sample unit.

Point quadrat (points) – a single point, used to sample vegetation data. The point quadrat is theoretically dimensionless.

Population (biological) – all individuals of one or more species within a specific area at a particular time.

Population (statistical) – the complete set of individual objects (sampling units) about which you want to make inferences.

Precision – the closeness of repeated measurements of the same value.

Quadrat – an area delimited for sampling flora or fauna; the sampling frame itself.

Random sampling – sampling units drawn randomly from the population of interest.

Relative abundance – the number of individuals per unit of sampling effort.

Relative Cover – The proportion of specific target vegetative cover compared to that of all the vegetative species in the community combined (Brower et al. 1998).

Restricted Random Sampling Method – a sampling method that divides the population of interest into equal-sized segments. In each segment, a single sampling unit is randomly positioned. Sampling units are then analyzed as if they were part of a simple random sample (Elzinga et al. 1998).

Sample – a subset of the total possible number of sampling units in a statistical population.

Sample size equations – use sample unit mean and standard deviation to determine if data have been collected from enough sample units to meet the sampling objectives.

Sample standard deviation – a value indicating how similar each individual observation is to the sample mean.

Sampling – the act or process of selecting a part of something with the intent of showing the quality, style, or nature of the whole.

Sampling objective – a clearly articulated goal for the measurement of an ecological condition or change value (Elzinga et al. 1998). Sampling objectives are generated from success standards. Elements of a sampling objective include the desired confidence level and confidence interval half-width, or the acceptable false-change error and acceptable missed-change error level.

Sampling units – the individual objects that collectively make up a statistical population.

Standard deviation – a measure of how similar each individual observation is to the overall mean value.

Shrub – a woody plant which at maturity is usually less than 6m (20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Species richness – the total number of species observed on a site.

Structures – any structure that is not expected to support vegetation during the monitoring period. Structures may include habitat structures, rocks, and other artifacts.

Stratified Random Sampling Method – The population of interest is divided into two or more groups (strata) prior to sampling. Within each stratum the sample units are the same. Sample units from different strata may or may not be identical. Random samples are obtained within each group (Elzinga et al. 1998).

Systematic Random Sampling Method – the regular placement of quadrats, points, or lines along a sampling transect following a random start.

Transect – a line to survey the distributions or abundance of organisms across an area.

Tree – a woody plant that at maturity is usually 6m (20 feet) or more in height and generally has a single trunk, unbranched for 1m or more above ground, and more or less definite crown (Cowardin et al. 1979). The species categories in this report follow Cooke (1997).

Vegetation structure – the physical or structural description of the plant community (e.g. the relative biomass in canopy layers), generally independent of particular species composition.

Wetland-dependent species (birds) – restricted in temporal or spatial distribution to wetlands based on an intrinsic feature or features of the environment (Finch 1989).

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